

CLAIMS

What is claimed is:

1. An electronic device having one of firmware and software stored in non-volatile memory therein, the electronic device comprising a fault-tolerant update agent employing a block-by-block memory update process, wherein the fault-tolerant update agent is capable of updating one of the firmware and software in the electronic device, and wherein the fault-tolerant update agent is capable of determining at least one last updated memory block in a previous update process during fault tolerant recovery following an interruption in an update process.

2. The electronic device according to claim 1, wherein the fault-tolerant update agent is adapted to provide efficient recovery services using of a backup memory block in non-volatile memory, the backup memory block being used to store resultant content generated by applying an exclusive or (XOR) transformation to contents of a first memory block and a second memory blocks, wherein the fault-tolerant update agent is capable of retrieving at least one of the contents of the first memory block by employing the backup memory block and the contents of the second memory block, and the contents of second memory block by employing the backup memory block and the contents of the first memory block.

3. The electronic device according to claim 1, further comprising:

a backup memory block in non-volatile memory;

a random access memory (RAM);

a first memory block in the non-volatile memory; and

a second memory block in the non-volatile memory, wherein the update agent is adapted to modify contents of the first memory block in RAM, and wherein the update agent is adapted to copy contents of the second memory block into RAM and save contents of the RAM in the backup memory block, and wherein the fault-tolerant update agent is capable of recovering not only modified contents of the first memory block from the contents of the backup memory block employing the contents of the second memory block in non-volatile memory, but also recovering the contents of the second memory block from the contents in the backup memory block by employing modified contents of the first memory block resident in the first memory block in non-volatile memory when an update process is interrupted.

4. The electronic device according to claim 3, wherein the update agent being adapted to copy contents further comprises injecting being executed by employing an exclusive or (XOR) operation to contents of at least two memory blocks.

5. The electronic device according to claim 3, wherein the fault tolerant update agent is adapted to copy the contents of the first memory block into RAM, update the RAM to generate modified contents of the first memory block, XOR the contents of the second memory block into RAM, and copy the contents of RAM into the backup memory block to provide fault tolerance before writing the modified contents of the first memory block from the RAM into the first memory block in non-volatile memory of the electronic device.

6. The electronic device according to claim 5, further comprising a memory processing order specifying an order that memory blocks are updated by the update agent, wherein the first memory block and the second memory block are disposed one of physically and logically in adjacent memory locations, and wherein the first memory block precedes the second memory block in the memory block processing order, and wherein the update agent is adapted to recover the modified contents of the first memory block from the backup memory block by employing the contents of the second memory block during a second attempt to update the electronic device, wherein when update of the first memory block having modified contents of the first memory block in RAM is interrupted due to a fault occurring during a first attempt to update the electronic device.

7. The electronic device according to claim 6, wherein recovery of modified contents of the first memory block from the backup memory block is executed by applying an exclusive or (XOR) operation to contents of the backup memory block and the contents of the second memory block.

8. The electronic device according to claim 7, wherein the update agent is adapted to recover contents of the second memory block from the backup memory block by employing modified contents of the first memory block, during a second attempt to update the electronic device, when update of the second memory block having the modified contents of the first memory block is interrupted due to a fault occurring during a first attempt to update the electronic device.

9. The electronic device according to claim 3, wherein the fault tolerant update agent employs the backup memory block to store and backup computed content and uses the backup computed content to recover modified content of the first memory block and unmodified content of the second memory block following a fault by, wherein the backup computed content of the backup memory block is used to recover from a fault occurring during one of a process of writing updated content to the first memory block and during modification of contents of the second memory block.

10. The electronic device according to claim 3, wherein writing to a memory block in the non-volatile memory is performed by a flash memory erase operation followed by a flash memory write operation, and wherein the update agent is capable of one of diminishing and eliminating a wait period for the flash memory erase operation to be completed before invoking the flash memory write operation, the one of diminishing and eliminating a wait period may be accomplished by invoking the flash memory erase operation prior to computationally modifying or assembling data to be written in RAM, wherein the flash memory erase operation being one of completed and near completion by an end of a computation wherein for the flash memory write operation immediately commences.

11. The electronic device according to claim 1, wherein the electronic device comprises at least one of a plurality of mobile electronic devices, and wherein the plurality of mobile electronic devices comprise at least one of a mobile cellular phone handset, personal digital assistant, pager, MP3 player, and a digital camera.

12. An electronic device capable of updating one of firmware and software in a fault-tolerant update process employing a fault-tolerant update agent, the electronic device comprising:

- a first memory block in non-volatile memory;
- a second memory block in non-volatile memory;
- a backup memory block in non-volatile memory; and

random access memory (RAM), wherein the fault tolerant update agent is adapted to copy contents of the first memory block into RAM, update the RAM generating a modified contents of the first memory block, XOR contents of the second memory block into RAM, and copy modified contents of RAM into the backup memory block for fault tolerance before writing the modified contents of the first memory block from RAM into the first memory block in the non-volatile memory.

13. The electronic device according to claim 12, wherein the electronic device comprises at least one of a plurality of mobile electronic devices, and wherein the plurality of mobile electronic devices comprise at least one of a mobile cellular phone handset, personal digital assistant, pager, MP3 player, and a digital camera.

14. A method of perform fault-tolerant updating of one of firmware and software resident in non-volatile memory in an electronic device, the method comprising performing a block-by-block update of a plurality of memory blocks in the non-volatile memory of the electronic device, wherein updated content of each memory block is backed up in a backup memory block before being written into a corresponding memory block.

15. The method according to claim 14, further comprising:
copying each memory block according to a memory block processing order to RAM;

updating the RAM when a memory block was not previously used in an exclusive or (XOR) operation while updating a previous memory block in the memory block processing order;

performing XOR operation on an updated memory block in RAM using contents of a next memory block in the memory block processing order;

saving contents of the updated memory block from the RAM in a backup memory block in non-volatile memory;

programming contents of the RAM to a corresponding memory block in the non-volatile memory; and

repeating the copying, updating, performing, saving, and programming until all the memory blocks in the memory block processing order have been updated.

16. The method according to claim 15, further comprising performing the XOR operation using a previous updated memory block, and wherein saving contents of the updated memory block is executed when the updated memory block is irretrievable after a fault occurrence from the backup memory block.

17. The method according to claim 16, wherein programming contents of the RAM to a corresponding memory block in the non-volatile memory comprises:

erasing contents of the memory block in non-volatile memory;

waiting for erasing to be completed; and

writing modified content into the memory block in non-volatile memory, wherein erasing contents of the memory block in non-volatile memory is initiated before updating contents of the RAM.

18. The method according to claim 17, wherein erasing is initiated on each memory block prior to updating when it is determined that each memory block is retrievable from the contents of the backup memory block, and wherein erasing is initiated on the backup memory block when it is determined that each memory block is irretrievable from the contents of the backup memory block.

19. The method according to claim 18, further comprising:

recovering update information when it is determined that a fault has occurred during an update process by determining the memory block being updated when the fault occurred; and

recommencing updating of the memory block determined to have been being updated when the fault occurred.

20. The method according to claim 19, wherein recommencing comprises:

determining if the memory block being updated when the fault occurred is retrievable from the backup memory block in one of an updated state and an original state;

retrieving the memory block being updated when the fault occurred by XORing the contents of the backup memory block with contents of a next block in a memory lock processing order if it is determined that the memory block being updated when the fault occurred is retrievable from the backup memory block in an updated state;

retrieving the memory block being updated when the fault occurred by XORing the contents of the backup memory block with contents of a previous updated memory block in the memory block processing order if the memory block being updated when the fault occurred is determined to be retrievable from the backup memory block in an original state;

programming the memory block being updated when the fault occurred using one of a retrieved updated memory block and a retrieved original memory block retrieved; and

continuing updating memory blocks until all memory block in the memory block processing order have been updated.

21. The method according to claim 14, wherein the electronic device may comprise at least one of a plurality of mobile electronic devices, and wherein the plurality of mobile electronic devices comprise at least one of a mobile cellular phone handset, personal digital assistant, pager, MP3 player, and a digital camera.